WE CLAIM:

1. An active air removal (AAR) system for purging air from an integrated extracorporeal blood circuit providing extracorporeal oxygenation of a patient's blood during cardiopulmonary bypass surgery adapted to be performed on a patient in the presence of a perfusionist, the AAR system comprising:

an air removal device incorporated in the extracorporeal blood circuit, the air removal device comprising:

an air removal device housing enclosing a chamber;

an air removal device purge port through the housing to the chamber; and

an air sensor supported by the air removal device housing in relation to the chamber adapted to provide an air sensor signal indicative of the presence of fluid or air in the air removal device housing;

an air removal device purge line coupled to the air removal device purge port and extending to a purge line connector adapted to be coupled to a vacuum source to apply suction to the air removal device purge port to draw air therefrom; and

an AAR controller comprising

a purge valve adapted to receive a portion of the purge line, the purge valve having a closed position to close the purge line and an open position to open the purge line; and

AAR controller circuitry operable to perform an AAR controller operating algorithm and to selectively change the purge valve closed position to the purge valve open position that further comprises:

means responsive to a perfusionist initiated command to enter a self-test mode that performs specified self-tests of components and operating conditions of the AAR system;

means for progressing to a standby mode when self-tests are completed to monitor specified components and operating conditions of

the AAR system, to power the air sensor, and to monitor the air sensor signal; and

means responsive to a perfusionist initiated command to enter an automatic mode from the standby mode enabling automatic movement of the purge valve from the closed position to the open position when the air sensor signal is indicative of air in the air removal device housing to allow air sensed in the air removal device to be purged through the purge line by the suction of the vacuum source.

2. The purging system of Claim 1, wherein the AAR controller comprises:

a power supply adapted to be coupled to mains power for supplying power to the components and AAR controller circuitry; and

a backup battery; and wherein:

the AAR controller circuitry further comprises:

means for determining if the power supply is operative and capable of supplying operating power to the AAR controller operating system;

means for determining if the backup battery is present and capable of supplying operating power to the AAR controller operating system; and

means for supplying operating power from the backup battery to the AAR controller operating system when the power supply is determined to be inoperative or incapable of supplying operating power to the AAR controller operating system and the backup battery is determined to be present and capable of supplying operating power to the AAR controller operating system.

3. The purging system of Claim 2, wherein the AAR controller further comprises means for alerting the perfusionist of the power state determined during the standby and automatic operating modes.

4. The purging system of Claim 3, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist in the standby and the automatic modes.

5. The purging system of Claim 4, wherein the AAR controller circuitry further comprises means responsive to a determination that the power supply is inoperative or incapable of supplying operating power to the AAR controller operating system for inhibiting the automatic movement of the purge valve from the closed position to the open position during the automatic mode.

6. The purging system of Claim 4, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist in the standby and the automatic modes.

7. The purging system of Claim 1, wherein the AAR controller circuitry further comprises:

means for monitoring operations or conditions of the AAR system;

means for determining an error state of the monitored operations or conditions of the AAR system; and

means for alerting the perfusionist of the error state.

8. The purging system of Claim 1, wherein the AAR controller further comprises:

means for monitoring operations or conditions of the AAR system;

means for determining an error state of the monitored operations or conditions of the AAR system; and

means for inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when an error state is detected.

9. The purging system of Claim 1, wherein the wherein:

the AAR controller further comprises means for determining the presence of fluid in the purge line; and

the AAR controller circuitry further comprises means for inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when fluid is detected in the purge line.

10. The purging system of Claim 9, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

11. The purging system of Claim 9, wherein:

the means for determining the presence of fluid in the purge line comprises a fluid in line (FIL) sensor arranged with respect to the purge valve; and

the AAR controller circuitry further comprises:

means for powering the FIL sensor to develop a FIL sensor signal indicative of the absence or presence of fluid in the purge line;

means for processing the FIL sensor signal to determine the presence of fluid in the purge line from the FIL sensor signal and to declare a FIL error state;

means for inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when a FIL error state is declared.

12. The purging system of Claim 1, wherein the AAR controller circuitry further comprises:

means for determining an error state of the air sensor; and

means for inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when an error state of the air sensor is detected.

13. The purging system of Claim 1, wherein the AAR controller further comprises an air sensor cable coupled between the AAR controller and the air sensor, and the AAR controller circuitry further comprises:

means for determining if electrical continuity is present in the connection of the air sensor cable between the AAR controller and the air sensor; and

means for inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when an error state of the air sensor cable is detected.

14. The purging system of Claim 1, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal indicative of vacuum in the purge line; and

the AAR controller circuitry further comprises means for determining a low vacuum condition from the vacuum signal.

15. The purging system of Claim 1, wherein the AAR controller further comprises:

means for determining an error state of the purge valve; and

means for inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when an error state of the purge valve is determined.

16. The purging system of Claim 15, wherein the purge valve error state determining means comprises:

means for commanding the purge valve to move into one of the purge valve open and closed positions;

means for sensing the purge valve position and providing a purge valve position signal indicative of the actual position of the purge valve; and

means for determining a position error state of the purge valve or the purge valve operating means when the sensed purge valve position signal does not confirm that the purge valve is in the commanded purge valve open position or purge valve closed position.

17. The purging system of Claim 16, wherein the purge valve comprises a pinch valve having a valve slot receiving the portion of the purge line and a pinch rod adapted to be moved between a purge valve closed position extending into the slot to compress the purge line and a purge valve open position retracted out of the slot.

18. The purging system of Claim 1, wherein:

the AAR controller circuitry further comprises means for determining an error state of the purging system and for formulating an alert message signal; and

the AAR controller further comprises a display screen responsive to the alert message signal for displaying a message readable by the perfusionist.

19. The purging system of Claim 1, wherein:

the AAR controller circuitry further comprises means for determining an error state of the purging system and for formulating an alert sound signal; and

the AAR controller further comprises at least one sound emitter that emits audible alert sounds in response to the alert sound signal that can be heard by the perfusionist.

20. The purging system of Claim 1, wherein:

the AAR controller circuitry further comprises means for determining an error state of the purging system and for formulating an alert light signal; and

the AAR controller further comprises at least one light emitter that emits visual light in response to the alert light signals that can be seen by the perfusionist.

21. A method of operating an active air removal (AAR) system to purge air from an integrated extracorporeal blood circuit providing extracorporeal oxygenation of a patient's blood during cardiopulmonary bypass surgery adapted to be performed in the presence of a perfusionist on a patient in an operating room, the operating method comprising:

providing an air removal device incorporated in the extracorporeal blood circuit, the air removal device comprising:

an air removal device housing enclosing a chamber;

an air removal device purge port through the housing to the chamber;

an air sensor supported by the air removal device housing adapted to provide an air sensor signal indicative of air in the air removal device housing;

an air removal device purge line coupled to the air removal device purge port and extending to a purge line connector adapted to be coupled to a vacuum source to apply suction to the air removal device purge port to draw air therefrom;

providing an AAR controller operating under the control of an AAR operating algorithm;

locating a portion of the air removal purge line extending through a purge valve of the AAR controller, the purge valve movable between a purge valve open position and a purge valve closed position;

coupling the air sensor with the AAR controller;

commencing the AAR controller operating algorithm that:

enters a self-test mode that performs specified self-tests of components and operating conditions of the AAR controller;

progresses to a standby mode when self-tests are completed to monitor specified components and operating conditions of the AAR controller, to power the air sensor, and to monitor the air sensor signal; and

responds to a perfusionist initiated command to enter an automatic mode from the standby mode enabling automatic movement of the purge valve from the closed position to the open position when the air sensor signal is indicative of air in the air removal device housing to allow air sensed in the air removal device to be purged through the purge line by the suction of the vacuum source.

22. The operating method of Claim 21, wherein the AAR controller operating system is powered by a power supply adapted to be coupled to mains power or by a backup battery, and wherein a power state self-test is performed in the self-test mode comprising:

determining if the power supply is operative and capable of supplying operating power to the AAR controller operating system;

determining if the backup battery is present and capable of supplying operating power to the AAR controller operating system; and

supplying operating power from the backup battery to the AAR controller operating system when the power supply is determined to be inoperative or incapable of supplying operating power to the AAR controller operating system and the backup battery is determined to be present and capable of supplying operating power to the AAR controller operating system.

23. The operating method of Claim 22, further comprising alerting the perfusionist of the power state determined by the power state self-test.

24. The operating method of Claim 23, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist in the standby and the automatic modes.

25. The operating method of Claim 22, further comprising inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when the air sensor signal is indicative of air in the air removal device housing if the power supply is determined to be inoperative or incapable of supplying operating power to the AAR controller operating system.

26. The operating method of Claim 23, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist in the standby and the automatic modes.

27. The operating method of Claim 21, further comprising:

determining an error state of the purging system; and

alerting the perfusionist of the error state.

28. The purging method of Claim 27, wherein the alerting step comprises:

formulating alert message signals related to the determined error state; and

displaying alert messages readable by the perfusionist on a display screen.

29. The purging method of Claim 27, wherein the alerting step comprises:

formulating alert sound signals related to the determined error state; and

applying the formulated alert sound signals to a sound emitter that emits audible alert sounds that can be heard by the perfusionist.

30. The purging method of Claim 27, wherein the alerting step comprises:

formulating alert light signals related to the determined error state; and

applying the formulated alert light signals to at least one light emitter that emits visual light in response to the alert light signals that can be seen by the perfusionist.

31. The operating method of Claim 21, further comprising:

determining an error state of the purging system; and

inhibiting the automatic movement of the purge valve from the closed position to the open position in the automatic mode when an error state is detected.

32. The operating method of Claim 31, wherein the error determining step comprises determining the presence of fluid in the purge line.

33. The operating method of Claim 32, wherein the AAR controller further comprises a fluid in line (FIL) sensor arranged with respect to the purge valve, and further comprising:

locating a further portion of the purge line through the FIL sensor; and

powering the FIL sensor to develop a FIL sensor signal indicative of the absence or presence of fluid in the purge line,

and wherein:

the error determining step comprises determining the presence of fluid in the purge line from the FIL sensor signal.

34. The operating method of Claim 33, wherein the AAR controller further comprises a mechanical release button interconnected with the purge valve adapted to enable manual opening of the purge valve by the perfusionist.

35. The operating method of Claim 31, wherein the error determining step comprises determining an error state of the air sensor.

36. The operating method of Claim 35, further comprising :

connecting an air sensor cable between the AAR controller and the air sensor; and

wherein the error determining step determines if electrical continuity is present in the connection of the air sensor cable between the AAR controller and the air sensor.

37. The operating method of Claim 31, wherein the error determining step comprises determining a low vacuum condition.

38. The operating method of Claim 37, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal indicative of vacuum in the purge line;

the error determining step determines a low vacuum error state if the sensed vacuum falls below a minimum vacuum.

39. The operating method of Claim 31, wherein the error determining step comprises determining a purge valve error state of the purge valve.

40. The operating method of Claim 39, wherein the purge valve error state determining step comprises:

commanding the purge valve to move into one of the purge valve open and closed positions;

sensing the purge valve position and providing a purge valve position signal indicative of the actual position of the purge valve; and

determining a position error state of the purge valve or the purge valve operating means when the sensed purge valve position signal does not confirm that the purge valve is in the commanded purge valve open position or purge valve closed position.

41. The operating method of Claim 21, wherein:

the purge valve comprises a pinch valve having a valve slot receiving the portion of the purge line and a pinch rod adapted to be moved between a purge valve closed position extending into the slot to compress the purge line and a purge valve open position retracted out of the slot; and

the purge valve opening step comprises moving the pinch rod from the purge valve closed position to the purge valve open position.

42. The operating method of Claim 41, further comprising:

determining a pinch valve error state of the pinch valve; and

inhibiting the automatic movement of the pinch valve from the closed position to the open position in the automatic mode when a pinch valve error state is detected.

43. The operating method of Claim 42, wherein the pinch valve error state determining step comprises:

commanding the pinch rod to move into one of the purge valve open and closed positions;

sensing the pinch rod position and providing a pinch rod position signal indicative of the actual position of the pinch rod; and

determining a position error state of the pinch valve when the pinch rod position signal does not confirm that the pinch rod is in the commanded purge valve open or purge valve closed position.

44. The operating method of Claim 21, wherein:

the AAR controller further comprises a vacuum sensor arranged with respect to the purge line to provide a vacuum signal indicative of vacuum in the purge line when the purge valve is closed; and

determining if the sensed vacuum exceeds a minimum vacuum; and

issuing an alert if the sensed vacuum does not exceed the minimum vacuum.